Method for Estimating the Dielectric Constant of Natural Gas Mixtures

A.H. Harvey [C, S] and E.W. Lemmon
Physical and Chemical Properties Division, National Institute of Standards and Technology, Boulder, CO, U.S.A.

The product of this work is a method for calculating the static dielectric constant (relative permittivity) of fluid mixtures, with an emphasis on natural gas. The dielectric constant is calculated as a function of temperature, density, and composition; the density of the mixture is calculated as a function of temperature and pressure by a fundamental mixture equation of state. Theory-based correlations were developed for the dielectric constant of all significant components of natural gas. This includes not only the light hydrocarbons, but also gases such as nitrogen and carbon dioxide. In many cases, these correlations took advantage of new, highly accurate data measured in cross capacitors by Schmidt and Moldover. These data allowed us to fine-tune some of the correlations to account for higher-order effects such as temperature dependence of the dielectric virial coefficients. For mixtures, the pure-component values are combined according to a procedure previously developed by Harvey and Prausnitz. This procedure makes use of the mixture density, which is available from the equation of state, and involves scaling the contributions to the polarization from each pure component to the reduced conditions of the mixture. It also contains an adjustable parameter for each binary pair; this parameter was fitted to binary data where available and can be set equal to zero in other cases. Results are compared with available data for mixtures of natural-gas components.